Title:

Understanding the coupling of surface, boundary layer, cloud and radiative processes in the Global Water and Energy Cycle

Principal Investigator: Dr. Alan K. Betts, Atmospheric Research: akbetts@aol.com

Co-Investigator: Dr. Michael G. Bosilovich, NASA/GSFC/GMAO: Michael.Bosilovich@nasa.gov

The hypothesis of this project is that understanding and evaluating the coupling of land-surface, boundary-layer, cloud and radiative processes in global models will lead to a better simulation of the Global Energy and Water Cycle in both climate and weather forecast models, and make a major contribution to the goals of NEWS.

Our central NASA ESE research question focus is

- What are the effects of clouds and surface hydrologic processes on Earth's climate?

Our research methodology has already proven invaluable in addressing a second question

- How can weather forecast duration and reliability be improved?

We anticipate that improved global reanalyses and models will allow us to address a third question

- How are global precipitation, evaporation and the cycling of water changing?

Models are a powerful tool for understanding the coupling of physical processes. We will diagnose, understand and evaluate the coupling of land-surface, boundary-layer, cloud and radiative processes in the GMAO GEOS-5 analysis and forecast model and its successors, using several approaches. We have developed a new methodology using the model daily averaged state to map the transitions of land-surface 'climate' of a model; and to quantify the links between the soil moisture, the surface heat fluxes, mean cloud-base and the short-wave and long-wave cloud forcing at the surface and the model dynamics. We will use this method to evaluate the GEOS-5 model on daily and seasonal timescales both on the scale of river basins and against flux station data (such as the CEOP and other long-term archives). We will also use idealized models to understand the coupling on timescales longer than a day between the vegetation-coupled evapotranspiration and CO_2 fluxes, the cloud field and the BL equilibrium. We will explore some of the climate controls on the amplitude of the diurnal cycle of 2-m temperature and relative humidity. This evaluation of the GEOS-5 against a range of datasets and idealized models will simultaneously lead to improvements in the model physical parameterizations and the model's representation of the land-surface and atmospheric state, and improve our understanding of the land-surface-cloud coupling in the global energy and water cycle.